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BUSINESS & TRANSPORTATION AGENCY
DEPARTMENT OF PUBLIC WORKS
DIVISION OF HIGHWAYS

WET TRACK ABRASION TESTING

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the 1990s, the number of people in the United States who are 65 years of age or older is projected to increase from 20 million to 30 million, and the number of people 75 years of age or older is projected to increase from 10 million to 15 million (U.S. Census Bureau, 1996). The number of people 85 years of age or older is projected to increase from 2 million to 4 million (U.S. Census Bureau, 1996). The number of people 90 years of age or older is projected to increase from 500,000 to 1 million (U.S. Census Bureau, 1996). The number of people 95 years of age or older is projected to increase from 100,000 to 200,000 (U.S. Census Bureau, 1996). The number of people 100 years of age or older is projected to increase from 10,000 to 20,000 (U.S. Census Bureau, 1996).

1. The first group of people who are not in the labor force are those who are not in the labor force because they are not in the labor force. This group is the largest group of people who are not in the labor force.

[illegible][illegible]

1990-1991, 1991-1992, 1992-1993, 1993-1994, 1994-1995, 1995-1996, 1996-1997, 1997-1998, 1998-1999, 1999-2000, 2000-2001, 2001-2002, 2002-2003, 2003-2004, 2004-2005, 2005-2006, 2006-2007, 2007-2008, 2008-2009, 2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2015-2016, 2016-2017, 2017-2018, 2018-2019, 2019-2020, 2020-2021, 2021-2022, 2022-2023, 2023-2024, 2024-2025, 2025-2026, 2026-2027, 2027-2028, 2028-2029, 2029-2030, 2030-2031, 2031-2032, 2032-2033, 2033-2034, 2034-2035, 2035-2036, 2036-2037, 2037-2038, 2038-2039, 2039-2040, 2040-2041, 2041-2042, 2042-2043, 2043-2044, 2044-2045, 2045-2046, 2046-2047, 2047-2048, 2048-2049, 2049-2050, 2050-2051, 2051-2052, 2052-2053, 2053-2054, 2054-2055, 2055-2056, 2056-2057, 2057-2058, 2058-2059, 2059-2060, 2060-2061, 2061-2062, 2062-2063, 2063-2064, 2064-2065, 2065-2066, 2066-2067, 2067-2068, 2068-2069, 2069-2070, 2070-2071, 2071-2072, 2072-2073, 2073-2074, 2074-2075, 2075-2076, 2076-2077, 2077-2078, 2078-2079, 2079-2080, 2080-2081, 2081-2082, 2082-2083, 2083-2084, 2084-2085, 2085-2086, 2086-2087, 2087-2088, 2088-2089, 2089-2090, 2090-2091, 2091-2092, 2092-2093, 2093-2094, 2094-2095, 2095-2096, 2096-2097, 2097-2098, 2098-2099, 2099-2100, 2100-2101, 2101-2102, 2102-2103, 2103-2104, 2104-2105, 2105-2106, 2106-2107, 2107-2108, 2108-2109, 2109-2110, 2110-2111, 2111-2112, 2112-2113, 2113-2114, 2114-2115, 2115-2116, 2116-2117, 2117-2118, 2118-2119, 2119-2120, 2120-2121, 2121-2122, 2122-2123, 2123-2124, 2124-2125, 2125-2126, 2126-2127, 2127-2128, 2128-2129, 2129-2130, 2130-2131, 2131-2132, 2132-2133, 2133-2134, 2134-2135, 2135-2136, 2136-2137, 2137-2138, 2138-2139, 2139-2140, 2140-2141, 2141-2142, 2142-2143, 2143-2144, 2144-2145, 2145-2146, 2146-2147, 2147-2148, 2148-2149, 2149-2150, 2150-2151, 2151-2152, 2152-2153, 2153-2154, 2154-2155, 2155-2156, 2156-2157, 2157-2158, 2158-2159, 2159-2160, 2160-2161, 2161-2162, 2162-2163, 2163-2164, 2164-2165, 2165-2166, 2166-2167, 2167-2168, 2168-2169, 2169-2170, 2170-2171, 2171-2172, 2172-2173, 2173-2174, 2174-2175, 2175-2176, 2176-2177, 2177-2178, 2178-2179, 2179-2180, 2180-2181, 2181-2182, 2182-2183, 2183-2184, 2184-2185, 2185-2186, 2186-2187, 2187-2188, 2188-2189, 2189-2190, 2190-2191, 2191-2192, 2192-2193, 2193-2194, 2194-2195, 2195-2196, 2196-2197, 2197-2198, 2198-2199, 2199-2200, 2200-2201, 2201-2202, 2202-2203, 2203-2204, 2204-2205, 2205-2206, 2206-2207, 2207-2208, 2208-2209, 2209-2210, 2210-2211, 2211-2212, 2212-2213, 2213-2214, 2214-2215, 2215-2216, 2216-2217, 2217-2218, 2218-2219, 2219-2220, 2220-2221, 2221-2222, 2222-2223, 2223-2224, 2224-2225, 2225-2226, 2226-2227, 2227-2228, 2228-2229, 2229-2230, 2230-2231, 2231-2232, 2232-2233, 2233-2234, 2234-2235, 2235-2236, 2236-2237, 2237-2238, 2238-2239, 2239-2240, 2240-2241, 2241-2242, 2242-2243, 2243-2244, 2244-2245, 2245-2246, 2246-2247, 2247-2248, 2248-2249, 2249-2250, 2250-2251, 2251-2252, 2252-2253, 2253-2254, 2254-2255, 2255-2256, 2256-2257, 2257-2258, 2258-2259, 2259-2260, 2260-2261, 2261-2262, 2262-2263, 2263-2264, 2264-2265, 2265-2266, 2266-2267, 2267-2268, 2268-2269, 2269-2270, 2270-2271, 2271-2272, 2272-2273, 2273-2274, 2274-2275, 2275-2276, 2276-2277, 2277-2278, 2278-2279, 2279-2280, 2280-2281, 2281-2282, 2282-2283, 2283-2284, 2284-2285, 2285-2286, 2286-2287, 2287-2288, 2288-2289, 2289-2290, 2290-2291, 2291-2292, 2292-2293, 2293-2294, 2294-2295, 2295-2296, 2296-2297, 2297-2298, 2298-2299, 2299-2300, 2300-2301, 2301-2302, 2302-2303, 2303-2304, 2304-2305, 2305-2306, 2306-2307, 2307-2308, 2308-2309, 2309-2310, 2310-2311, 2311-2312, 2312-2313, 2313-2314, 2314-2315, 2315-2316, 2316-2317, 2317-2318, 2318-2319, 2319-2320, 2320-2321, 2321-2322, 2322-2323, 2323-2324, 2324-2325, 2325-2326, 2326-2327, 2327-2328, 2328-2329, 2329-2330, 2330-2331, 2331-2332, 2332-2333, 2333-2334, 2334-2335, 2335-2336, 2336-2337, 2337-2338, 2338-2339, 2339-2340, 2340-2341, 2341-2342, 2342-2343, 2343-2344, 2344-2345, 2345-2346, 2346-2347, 2347-2348, 2348-2349, 2349-2350, 2350-2351, 2351-2352, 2352-2353, 2353-2354, 2354-2355, 2355-2356, 2356-2357, 2357-2358, 2358-2359, 2359-2360, 2360-2361, 2361-2362, 23

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INTRODUCTION

The most important test method in the design of emulsified asphalt slurry seal is the Wet Track Abrasion Test. This test was originated and first described by W. J. Kari and L. D. Coyne⁽¹⁾. The test as described by Kari and Coyne consists of preparing specimens of slurry material and after curing and soaking in water, subjecting the samples to an abrasion test. The abrasion test consists of a rotating rubber hose mounted on a conventional laboratory mixer. The sample is abraded for five minutes under water, dried, and weighed. The loss of slurry in grams per square foot is called the "wear value". In later publications, other authors have changed the term "wear value" to "abrasion loss".

Another method of measuring abrasion loss has been described by W. J. Harper, R. A. Jimenez and B. M. Gallaway⁽²⁾. This test is known as the Young Wet Track Abrasion Device. The apparatus is constructed so that the testing head is mounted on an inclined axis. The testing head is a hard rubber annulus approximately two inches high and 3-7/8 inches in diameter. Tests with this apparatus are performed in a manner similar to that described by Kari.

The International Slurry Seal Association has also proposed a method of test for measuring abrasion loss based on a device similar to the Young apparatus. The specimens are prepared, cured and tested under water in a manner similar to that first described by Kari.

One of the very important contributions provided by Kari and Coyne was the furnishing of a field performance correlation with the Wet Track Abrasion Test. The test was correlated to field performance by visually rating more than one hundred field projects and also determining the abrasion loss on slurry prepared from each aggregate used in the field. The results of this excellent study showed that slurry seal coats having high abrasion values also exhibited excessive sanding in the field. Mixes showing more than one hundred grams of abrasion loss in the laboratory showed excessive deterioration in the field. Samples with less than one hundred grams wear provided satisfactory performance. On the basis of these results, Kari and Coyne recommended that a maximum wear value of seventy five grams per square foot be used in the design of a slurry seal coat. This contribution to slurry seal design has provided an excellent method for determining service performance together with recommendations for values to be used in design.

MODIFICATIONS IN THE WET TRACK ABRASION TEST PROCEDURE

The present California Division of Highways method of design for slurry seal coat is described in California Test Method No. 355. We are presently attempting to simplify the test procedure and also to improve our presently used Wet Track Abrasion Test. The purpose of this discussion is to describe certain changes in our Wet Track test apparatus and procedure.

We presently use caster wheels on our abrasion unit. These wheels wear fairly rapidly and we have no control over the

manufacture. The specific style of wheel may be changed depending on the need within the furniture industry. Therefore, after a series of tests we found that a tool hardened steel wheel with a coarse diamond knurled surface approximately 1/32" depth would provide an excellent wearing unit. This wheel has the advantage of being easily produced to specifications in any machine shop and may be easily replaced after a specified amount of wear. A drawing of the wheels and the abrasion test assembly is shown in Figure 1. This assembly may be mounted in any unit capable of rotating the assembly at a speed of 30 ± 1 RPM.

The decision to use steel wheels required a correlation with the apparatus described by Kari and Coyne since our design method is based on their recommendation of a maximum wear value of 75 grams per square foot. Therefore, specimens were prepared from different aggregates and tested in the Chevron Asphalt Co. unit and also in our unit using both our original caster wheels and our new steel wheels. A typical result for one aggregate source is shown in Figure 2. The results indicate that a ten minute test period with the California unit equipped with steel wheels produces the same wear as the Chevron Asphalt unit. This was also found with other aggregate sources. Therefore, this wear period is now specified in our revised test procedure.

Further studies to standardize the abrasion test indicated that steel wheel wear would influence the final recommendation for emulsion content. Therefore, a standard slurry was developed which may be used for determining wheel wear and the need for application of a correction factor or replacement. On the basis of our studies, we estimate that 75-100 samples may be tested with a set of wheels before they will be worn sufficiently to require a correction factor.

After a number of trials a slurry containing 20-50 mesh Ottawa sand, 2% Type II Portland Cement, 5% water and 10% emulsion was selected as a standard for checking wheel wear. The curing period has been standardized at 16 ± 1 hours. Details of the procedure are shown in Appendix A. One problem in the use of this material is wheel pickup. It is necessary to stop the abrasion process once or twice during the test and clean the wheels with a wire brush. New wheels should provide a loss of about 300 grams/sq. ft.

Calculations indicate that a 15% reduction in abrasion loss by wheel wear would change the design asphalt content determined with new wheels by approximately 0.9%. Therefore, no correction is required up to 15% reduction in abrasion loss. On the basis of observations on knurled wheel wear, it was decided to require replacement of wheels when a reduction of more than 40% in abrasion loss is measured. In the 15-40% range a correction is applied to the measured abrasion loss as shown in Appendix A.

We believe that these modifications in the Wet Track Abrasion Test procedure will provide more consistent results, especially when the apparatus is used over a period of time in the design of slurry seal coats.

WET TRACK ABRASION TEST STUDIES

We have found that both the premix moisture and the emulsion content influence the performance of a slurry seal coat and both must be evaluated in the design. Studies were performed in which the emulsion content was held constant and the premix moisture was

varied. It was found that the surface abrasion loss was high with specimens containing insufficient premix moisture. The abrasion loss then decreased as the premix moisture increased until a point was reached where an excess of moisture was used. At this point the abrasion loss immediately began to rise. This change in abrasion loss caused by the premix moisture content is shown in Figure 3.

An examination of the test specimens indicated that insufficient premix moisture affected workability and created a rough textured surface of sufficient magnitude to contribute toward increased surface abrasion. Excess amounts of premix moisture caused a dilution of the emulsion with subsequent migration of the asphalt to the surface. This was not visually in evidence until the specimen had cured. The cured specimens had free asphalt on the surface forming a skin. Once the abrasion wheels broke through the surface skin, a high amount of abrasion occurred due to the lack of asphalt in the lower portion.

These studies indicate that the design must not only provide information on the emulsion content, but also on the premix moisture content. Also large variations in premix moisture content may affect field performance.

SUMMARY

It is evident that the Wet Track Abrasion Test is a very important test in the design of a slurry seal coat. We note that it will not only provide information on the optimum emulsion content based on an accepted abrasion loss, but also on the required premix moisture.

Studies reported in this paper provide methods to standardize the equipment used in the Wet Track Abrasion Test.

REFERENCES

1. W. J. Kari and L. D. Coyne, "Emulsified Asphalt Slurry Seal Coats," Association of Asphalt Paving Technologists, Vol. 33, p. 502, 1964.
2. W. J. Harper, R. A. Jimenez and B. M. Gallaway, "Effects of Mineral Fillers in Slurry Seal Mixtures," Highway Research Record 104, 1965.

APPENDIX A

METHOD FOR CALIBRATION OF WET TRACK ABRASION TEST WHEELS

SCOPE

This is an appendix to Test Method No. Calif. 355-B (Method for Design of Slurry Seal). This method is used to calibrate the steel wheels used in the Wet Track Abrasion Test. It provides a measure of wear on the wheels by means of a standard slurry mixture.

PROCEDURE

A. Apparatus

1. Drying oven or hot plate
2. Slurry abrasion pan
3. Scale of sufficient capacity to weigh a 1,000 gram test sample to an accuracy of ± 1 gram.
4. Circular metal rings, 10 inches inside diameter, with vertical sides $1/4$ inch deep.
5. Abrasion apparatus - See Figure I of Test Method 355.
6. Mechanical mixer (Bituminous Mix) or other power device to drive abrasion apparatus at 30 RPM ± 1 . See Figure II of Test Method 355.

B. Materials

1. Roofing felt 50-60 pound weight.
2. Ottawa Sand 20-50 gradation.
3. Type II Portland Cement
4. SS-1 emulsion (conforming to AASHO specifications).

C. Preparation of Samples

1. Place metal ring on disc cut from roofing felt to outside diameter of ring.
2. Prepare in triplicate, the following slurry mixture, in the order indicated and mix thoroughly after each addition.
 - a. 600 grams dry Ottawa sand.
 - b. 2% Type II cement (12 grams)
 - c. 5% water (30 grams)
 - d. 10% emulsion (60 grams)
3. Pour slurry into metal rings. Using a straight edge resting on the ring, strike off the excess material with a sawing motion, so that the surface will be flush with the ring. Use one saw pass only with the straight edge.
4. Allow each specimen to set at room temperature for 15 minutes, remove metal ring and place in 140°F oven, cure for 16 hours \pm 1 hour.
5. Record the weight, cool to room temperature, place each specimen in a pan, and cover the surface of the specimen with water. Allow to stand in this water bath, at room temperature, for one hour.
6. Remove specimen from water bath, place in abrasion pan, cover surface with water, apply abrasion wheels.
7. Abrade specimen at the rate of 30 \pm 1 RPM for 10 minutes. (Wheels may have to be stopped and cleaned due to pickup at least once.)
8. Remove specimen and place in 140°F oven until constant weight is reached. Subtract this weight from the oven dry

weight obtained before abrasion test. Record the difference in weight and multiply by 5.00 (abraded area = 1/5 sq. ft.)

9. Average the results of the three specimens. (New wheels should provide a loss of about 300 gms/sq. ft.)
10. Use the loss obtained with new wheels as the standard to compare used wheel losses.
11. Use the following criteria to calibrate used wheels:

$$\% \text{ Abrasion Loss} = \frac{\text{Grams Loss (New Wheels)} - \text{Grams Loss (Used Wheels)}}{\text{New Wheel Loss (Grams)}} \times 100$$

0 - 15% no correction required

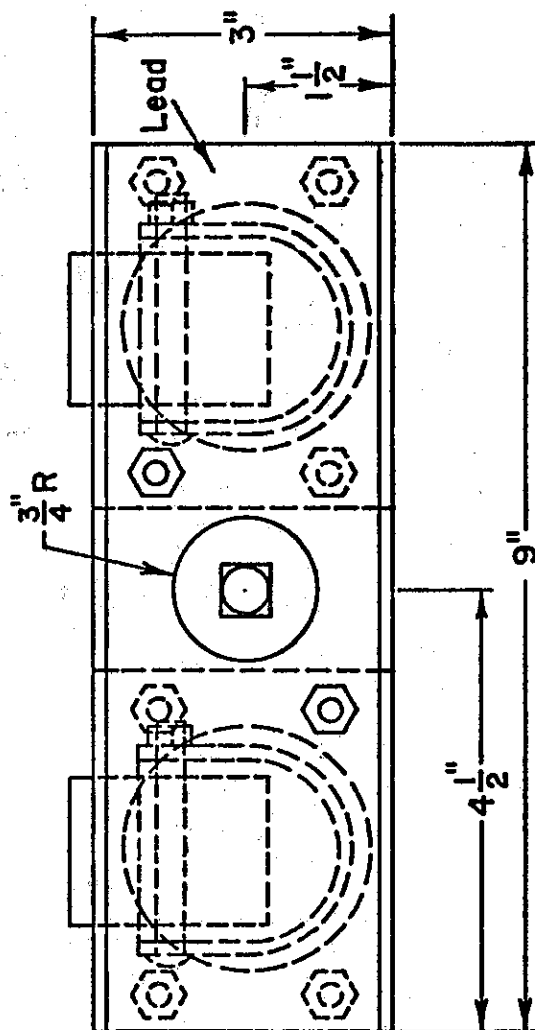
16% - 40% correction required

40%+ replace wheels

12. Calculate correction factor and record for applying to grams loss obtained with the used wheels. (Factor x gms. loss = corrected grams loss).

$$\text{Correction Factor} = \frac{\text{New Wheel Loss}}{\text{Old Wheel Loss}}$$

ABRADING ASSEMBLY



Sufficient Lead to make total weight of apparatus 15.0 lbs.

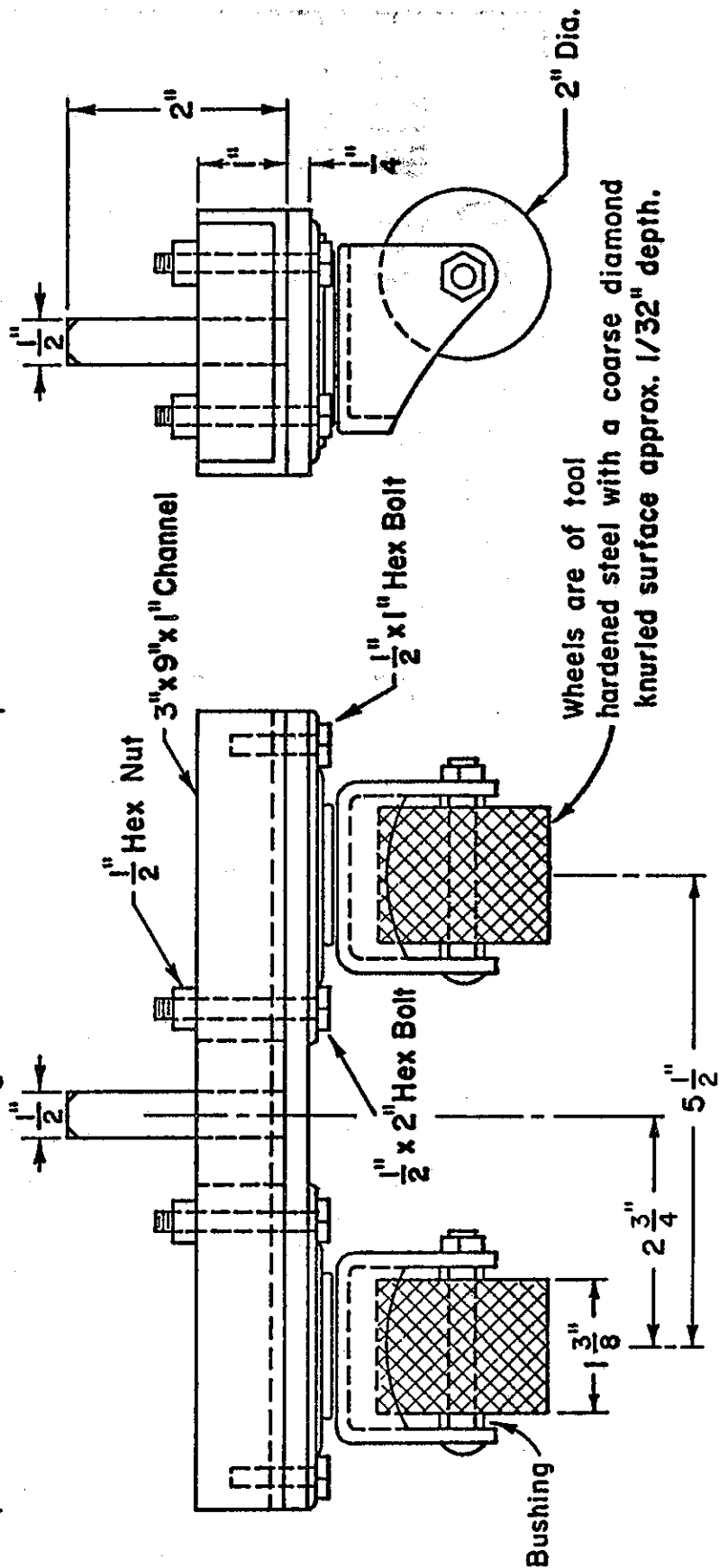


Figure 1

Figure 2

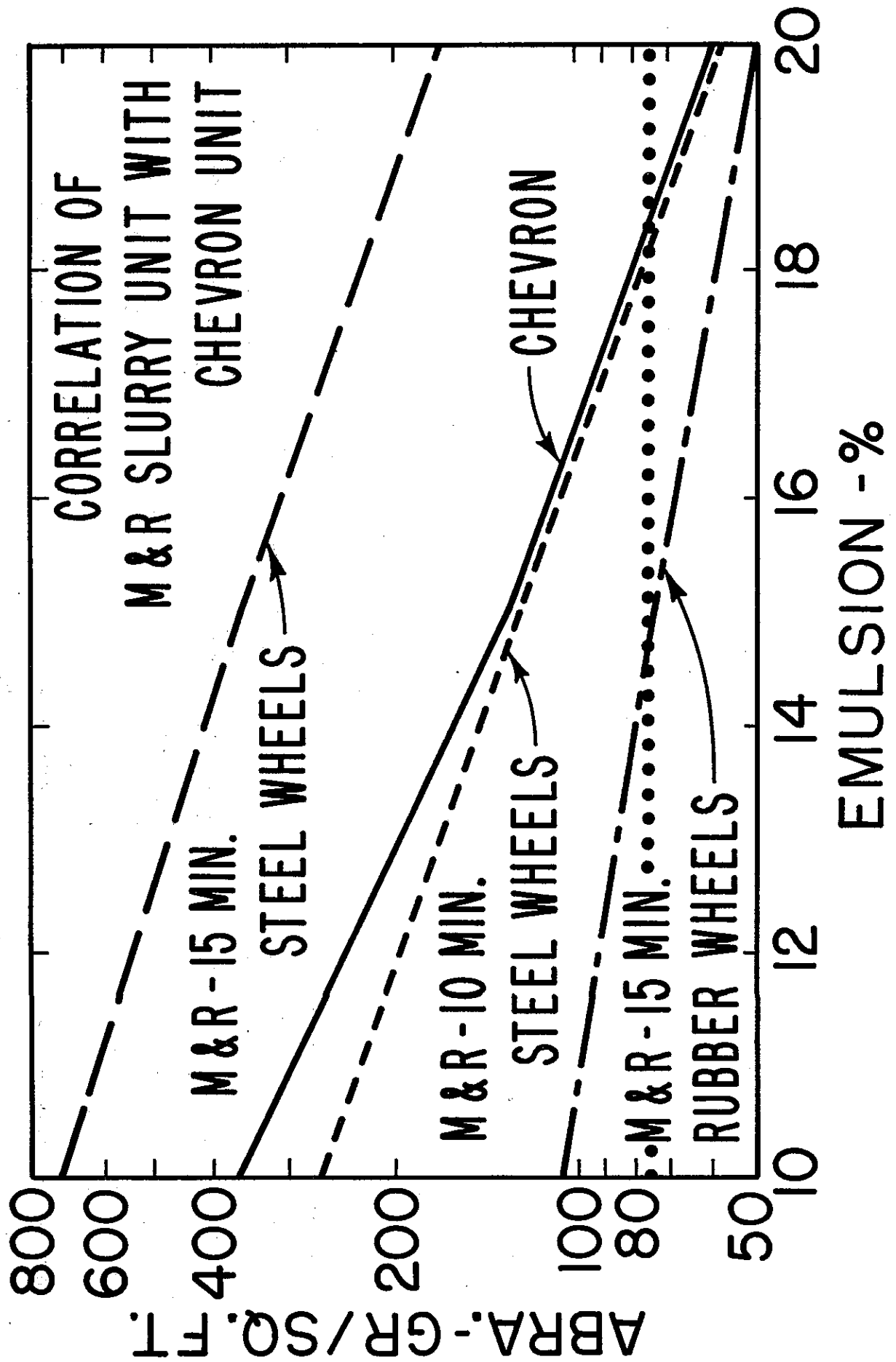
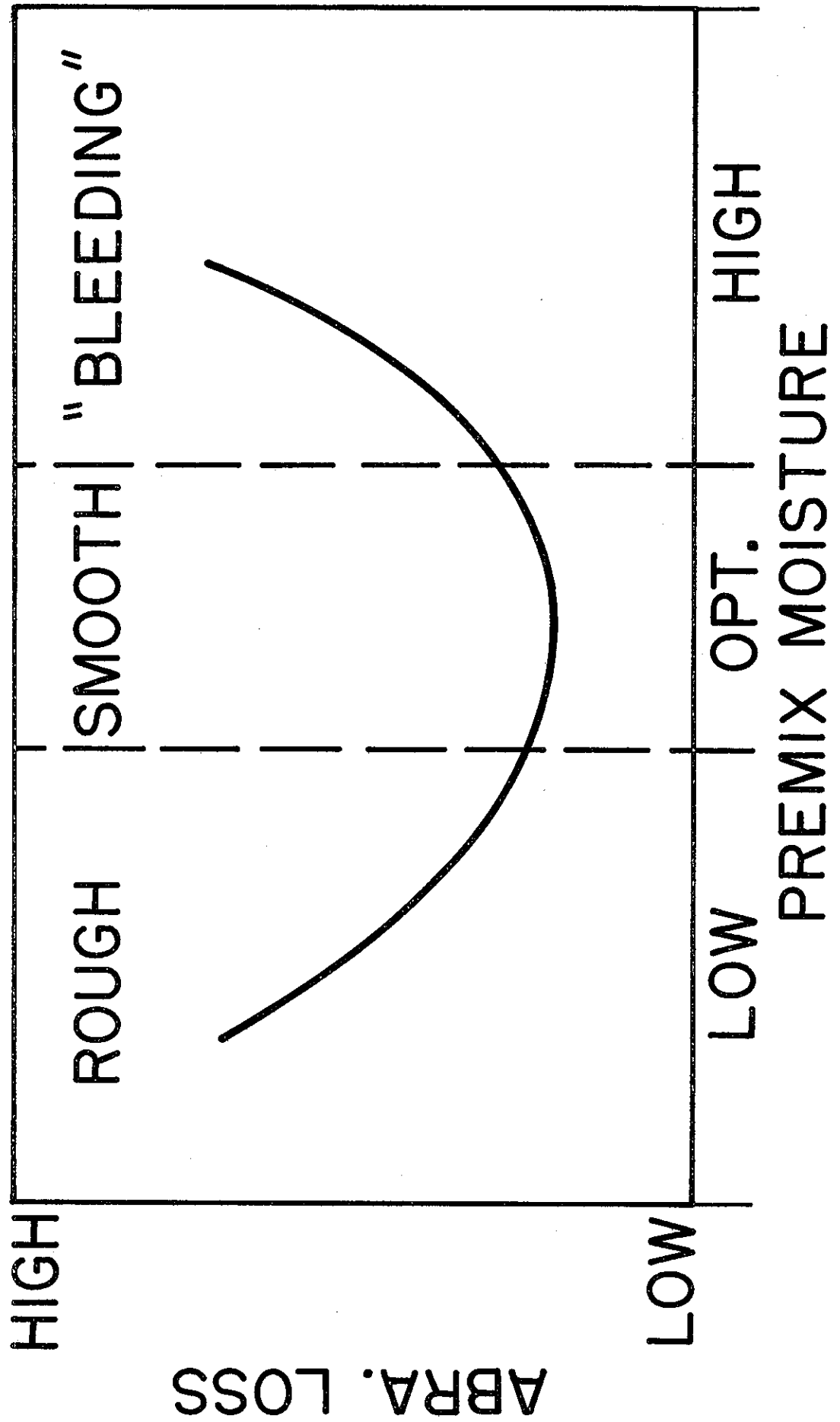


Figure 3

TYPICAL ABRASION RESULTS



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VBHV TOCC